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Composition, Clouds, and Origin of Jupiter's Atmosphere- A Case for Multiprobes

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The observed supersolar proportions of heavy elements, C, N, S, Ar, Kr, and Xe on Jupiter, point to a planet whose origin is far more complex than previously imagined. Current hypotheses for the formation of Jupiter and evolution of its atmosphere, including cold icy planetesimals, and clathrate-hydrates, invoke large quantities of water with O/H enriched 1-3 times the other heavy elements. Water was presumably the original carrier of heavy elements to Jupiter, but its abundance in the deep well-mixed atmosphere remains unknown. Although no water clouds were detected *in situ* in the hotspot entry site of the Galileo probe, indirect imaging evidence from convective cloud towers and lightning points to the presence of large quantities of water on Jupiter. How much water and where? Is it uniform in the well-mixed part of the deep atmosphere? Furthermore, ammonia clouds are found to vary dramatically over the planet, again pointing to large variability in the ammonia abundance. Is ammonia abundance uniform in the well mixed atmosphere as expected , or does it vary from place to place? The answers to these and related composition and dynamics questions are important for developing credible scenarios of the formation of Jupiter and its atmosphere, and would require cleverly instrumented deep entry probes deployed in different parts of Jupiter. However, many technological challenges must be overcome first to enable successful missions to the deep interiors of Jupiter and the other giant planets. Finally, other techniques to measure water remotely, including microwave radiometry, should be explored in the interim, as they could be useful in guiding the detailed design of multi-faceted deep probe missions to Jupiter and the other giant planets in the next decade.

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